Response to the PCT Written Opinion

1) The following opinions were expressed in the Response dated November 9, 2004 issued by the PCT International Searching Authority.

(1) Claim 1 lacks novelty based on Document 1. As the reason for this, the Examiner is stating that "Document 1 describes a sputtering target having a structure in which the crystallite size is 45nm or less".

(2) Claims 2 to 4 lack inventive step based on Document 1. As the reason for this, the Examiner is stating that "Document 1 describes a sputtering target formed from an alloy having a three-component system or greater, and having a structure in which the crystallite size is 45nm or less, and a person skilled in the art could have easily limited the average crystallite size to be 1nm to 5nm, and 1nm to 2nm, and there is no noticeable effect".

(3) Claims 5 to 12 lack inventive step based on Documents 1 to 7. As the reason for this, the Examiner is stating that "Document 2 describes a sputtering target formed from an alloy having a three-component system or greater with Zr, Fe as its primary components. Document 3 describes a sputtering target formed from an alloy having a three-component system or greater with Pt, Pd as its primary components. Document 4 describes a sputtering target formed from an alloy having a three-component system or greater with Fe as its primary component. Document 5 describes a sputtering target formed from an alloy having a three-component system or greater with Fe, Co as its primary components. Document 6 describes a sputtering target formed from an alloy having a three-component system or greater with Co as its primary component. Document 7 describes a sputtering target formed from an alloy having a three-component system or greater with Cu as its primary component. And the present invention could have been easily achieved by combining Document 1 and these Documents 2 to 7".

(4) Claim 13 lacks inventive step based on Documents 1 to 8. As the reason for this, the Examiner is stating that "Document 8 describes the manufacturing method of a sputtering target by sintering powder prepared via gas atomization, and the present invention could have been easily devised by combining Document

1 and Document 8".

The Cited Documents are as follows:

Document 1: JP2003-3222

Document 2: JP2000-144380

Document 3: WO2002/016663

Document 4: JP2002-212716

Document 5: JP5-17868

Document 6: JP2000-207725

Document 7: JP2002-69550

Document 8: JP2002-363615

2) Since it seems that the scope of claims filed in this PCT application was somewhat broad and therefore overlaps with Document 1, we have amended the claims in the Amendments (amendments under Article 34) filed on the same date. In other words, claim 1, claim 4, claim 5 and claim 6 have been deleted, the conditions of these deleted claims have been consolidated into independent claim 2, and the constituent elements of "relative density of 96.4% or more" and "amorphous material" described in the Examples were introduced to clarify and limit the invention. Incidentally, it is evident that this amendment does not constitute new matter of alteration of gist since these conditions are described in the Description, particularly in the Examples.

As a result, claim 2 (independent claim) and all claims dependent on claim 2 possess novelty and inventive step. The reason for this is explained in detail below.

Incidentally, for the convenience of comparison with the Cited Documents, the amended claims are once again indicated below.

1. (Deleted)

2. A sputtering target having a structure where the average crystallite size is 1nm to 5nm, comprising an alloy having a three-component system or greater containing at least one element selected from among Zr, Pt, Pd, Fe, Co and Cu as

its primary component in an atomic ratio of 50at% or more, comprising the requirements of a metallic glass satisfying an atomic radius difference of 12% or more and negative heat of mixing, having a relative density of 96.4% or more, and is an amorphous material obtained by sintering gas atomized powder.

3. The sputtering target according to claim 1 having a structure where the average crystallite size is 1nm to 2nm.

4. (Deleted)

5. (Deleted)

6. (Deleted)

7. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system or greater with Zr as its primary component, and further containing at least one or more elements selected from among Cu, Ni and Al.

8. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system or greater with Pt as its primary component, and further containing at least one or more elements selected from among Pd, Cu and P.

9. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system or greater with Pd as its primary component, and further containing at least one or more elements selected from among Cu, Ni and P.

10. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system with Fe as its primary component, and further containing B and at least one component selected from among Ti, V, Cr, Zr, Nb, Mo, Hf, Ta and W.

11. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system with Co as its primary component, and further containing at least one or more elements selected from among Fe, Ta and B.

12. The sputtering target according to claim 2 or claim 3, comprising an alloy having a three-component system with Cu as its primary component, and further containing at least one or more elements selected from between Zr and Ti.

13. A manufacturing method of the sputtering target according to any one of claims 2, 3 or 7 to 12, wherein said sputtering target is manufactured by sintering

gas atomized powder.

3) The Examiner is indicating that the present invention could have been easily devised mainly based on Document 1 (JP2003-3222). Nevertheless, the prescription of the crystallite size described in Document 1 is for improving the recording characteristics of a rewritable optical disk recording film, and is only effective in an AgInSbTe recording film. In addition, this is not a metallic glass.

Meanwhile, the present invention of claim 2 prescribes the crystallite size for improving the characteristics upon sputtering a metallic glass, and relates to entirely different technology in comparison to Document 1. This point will be described in detail later, but the features of the present invention are explained once again below.

Generally speaking, metallic glass is an alloy group that becomes amorphous even at an extremely slow cooling rate in comparison to conventional amorphous alloys. Therefore, a bulk metallic glass target has been manufactured based on the rapid solidification method via melting and casting. And the research and development of this bulk metallic glass target is currently placed in a situation of laying emphasis on discovering an alloy that will become amorphous at the slowest cooling rate.

Whereas, the present inventors discovered that there are several problems in a bulk metallic glass target manufactured based on the rapid solidification method via melting and casting. In other words, since the elements constituting the metallic glass is a three-component system or greater, if a sufficient amorphous state is not realized upon solidification, an uneven phase of composition is generated in the crystallized structure.

Further, when preparing a bulk metallic glass via melting and casting, it is extremely difficult to control the cooling rate, and there are cases where the cooling rate becomes slower than the critical cooling rate. In particular, when preparing a large size bulk body, a cooling speed gradient will occur in the bulk body, and a part of the bulk will be crystallized easily. As a result, a part of such bulk body will crystallize, and unevenness will arise in the composition of the bulk metallic glass.

When a metallic glass having this kind of uneven composition is sputtered, deterioration in sputtering characteristics such as the generation of nodules and arcings will occur as a matter of course, the there will be an adverse effect on the uniformity of the film. This is the conventional manufacturing method of a metallic glass sputtering target based on the rapid solidification method via melting and casting.

The present invention was devised in order to overcome the foregoing drawbacks in the manufacture of a bulk metallic glass via melting and casting as described above, and manufactures a sputtering target by preparing raw material powder via the gas atomization method and then sintering the obtained powder.

Originally, it is difficult to consider that a metallic glass sputtering target manufactured with powder metallurgy would be able to obtain a sputtering target of the same quality as the bulk metallic glass manufactured via melting and casting; rather, it would be natural to consider this to be impossible. Nevertheless, with the present invention, it became possible to manufacture a sputtering target that is superior to the bulk metallic glass manufactured via melting and casting.

As described in detail in the Description, upon sintering the raw material powder via the gas atomization method, the cooling rate gradient in the powder is extremely small, and, even if crystallization occurred, there is a significant advantage in that the unevenness of the composition will be extremely small. Further, it is possible to minimize the influence on the changes in process that often occur in the actual manufacturing process, and a metallic glass having a uniform composition can be prepared stably, and the present invention is significantly superior to the melting and casting method with respect to these points. Moreover, this is a sputtering target formed from a new metallic glass, and the present invention provides a novel manufacturing method of such a metallic glass target.

4) To repeat the foregoing explanation, the invention of Document 1 is not a metallic glass. Therefore, there is no disclosure regarding the characteristics, conventional problematic issues, and objects to be achieved regarding a metallic glass, and the present invention and Document 1 are not even based on the

common technical foundation.

Even if the prescription of the crystallite size, which is one of the constituent elements, just happened to be common, the prescription of the crystalline being 450Å (45nm) or less is for improving the recording characteristics of a rewritable optical disk recording film, and is only effective in an AgInSbTe recording film. Thus, this is not related to the crystallite size required in a metallic glass.

Further, the present invention has a "structure where the average crystallite size is 1nm to 5nm", but the crystallite size tolerated in Document 1 is 45nm or less. This is a difference of nearly one digit, and it cannot be said that this is a favorable condition.

Further, Document 1 has no description of density. In the invention of claim 2, since a target obtains characteristics that are the same or better than the bulk metallic glass via melting and casting by sintering raw material powder prepared with the gas atomization method, it is necessary to possess a high relative density of 96.4% or more, and, therefore, density will become an important constituent element.

Nevertheless, Document 1 does not have any description regarding density, and has no interest in the issue. Generally speaking, density is an important issue in a sintered target. This is because pores are easily created in a sintered body in comparison to a melted/cast product, and such pores will have a strong effect on the target material, sputtering characteristics, and even the property of the thin film.

The reason Document 1 does not indicate density as a required element of the invention is because it does not affect the property of the thin film in any way, or the improvement in density cannot be expected at all.

In either case, the invention of claim 2 and Document 1 that does not disclose density are clearly different, and this clarifies that the two are not based on the common foundation. And, in Document 1, the purpose of the target is to simply form an AgInSbTe recording film, and it is evident that this is different from the present invention.

Further, the requisite elements of claim 2; namely, "the requirements of a

metallic glass satisfying an atomic radius difference of 12% or more and negative heat of mixing", "sintering gas atomized powder" and "is an amorphous material" are not described in Document 1.

Accordingly, the invention of claim 2 and Document 1 clearly have technical differences, and it would be erroneous to say that the invention of claim 2 could have been easily achieved based on Document 1.

5) Claims 3 and 7 to 13 are all dependent on claim 2. Although the Examiner is indicating that these claims could have been easily devised based on the combination of Document 1 and other Documents 2 to 8, Documents 2 to 8 have no description whatsoever regarding the requirements of claim 2, and are even more unrelated than Document 1.

Therefore, no matter how the fragmentary techniques of Documents 2 to 8 are combined, it is evident that such Documents 2 to 8 cannot be used as grounds to indicate that the invention of claims 3 and 7 to 13 could have been easily devised thereon.

6) Accordingly, the invention of claims 2, 3 and 7 to 13 could not have been easily achieved based on foregoing Document 1 to Document 8. In addition, the present invention yields superior results as explained in the Description.

The inappropriate descriptions in the Description and claims of this PCT application have all been corrected, and the present invention possesses novelty and inventive step, and therefore also possesses patentability.